

Sensory baby vest for the monitoring of infants

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Abstract

Continuous monitoring of physiological parameters is very often necessary for the evaluation of health conditions, diagnostic reasons and the detection of life or health threatening events. For infants, especially, who cannot provide any feedback about discomfort or health complaints it is an important issue to collect objective data under everyday conditions. The demand of physicians for the development of monitoring and diagnostic systems which are easier to handle and less obtrusive than the commonly used medical systems was the motivation for the presented project. Another motivation was the concern frequently expressed by parents about the danger of apparently life threatening events (ALTE) or even the problems of sudden infants death syndrome (SIDS).

The developed sensory baby vest includes fully integrated sensors for the parameters respiration, heart rate, temperature and humidity, to detect excessive sweating, for the continuous monitoring of infants under clinical and home conditions. It will allow the early detection of potential life threatening events calling for rescue as well as the recognition of the development or progression of diseases at an early stage. Health protection or even life-saving thus will be enabled in time. A variety of principles for the measurement of the parameters has been assessed for the integration into garments. Prototypes have been manufactured incorporating the chosen sensing principles with textile and textile-compatible technologies. Currently, the prototypes are clinically tested for durability, handling and signal quality.

1. Introduction

The number of approx. 700.000 life births in Germany is overshadowed by a large number of infant deaths for various reasons shown in Tab. 1. In spite of the precautions in neonatal care resulting in clearly reduced numbers of SIDS cases in developed countries [1] SIDS together with respiratory distress and congenital malformations e.g. of the circulatory

system represents a large group of infant deaths [2]. Many of those might have been avoided by appropriate health monitoring or better diagnostic tools and subsequent better understanding of the mechanisms [3].

It was the aim of this project to incorporate multiple sensory functions in a very small piece of garment, the baby vest, without making it bulky, unhandy, too warm, and without hindering the loving interaction with the infant or giving the child a diseased appearance as shown in Fig. 1.

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Fig. 1.: Infant with multi-sensory baby vest connected to data acquisition unit

manufactured incorporating the chosen sensing principles with textile and textile-compatible technologies. The shown prototype was produced using weaving, knitting, sewing, printing, and coating technologies common in textile and clothing industry.

Tab. 1: Causes of infant death during the first year of life in Germany (2003) [2]

Infant death in Germany, 2003				
Selected causes	Total	At the age of up to 1 month	2 – 12 months	Percentage
Diseases overall	2990	1495	1496	100 %
Respiratory distress	82	64	18	3 %
SIDS	372	32	340	12,4 %
Congenital malformations	799	365	434	26,7 %

2. Materials and methods

The main focus of the design of the sensory baby vest was on processes and materials that are compatible with the body and skin as well as with textile manufacturing processes. The permanence against body fluids and laundry conditions was another requirement.

- Signal transmission

Flexible, teflon isolated micro wires (AWG 36) have been woven into a narrow band forming a textile ribbon cable (Fig. 2) to collect the signals from the distributed sensors. This band is fixed on the inner side

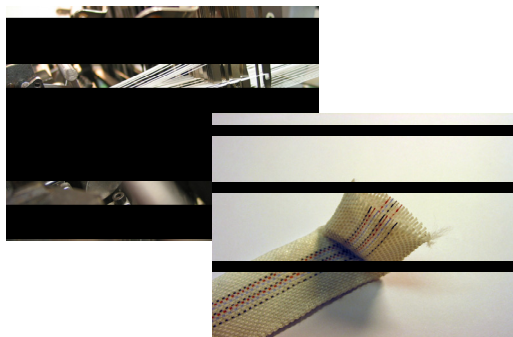


Fig. 2: Flexible textile ribbon cable for signal transmission

of the vest and covered by another textile layer for best comfort. Single leads are isolated from the ribbon according to the position of the sensors.

- Respiratory sensors

Separate sensors for breast and abdominal breathing are integrated into the front of the vest as straps that can be closed and adjusted by push-buttons. The resistive strain sensors comprise carbon-filled



Fig. 3: SEM micrograph of the electrode on the inner side of the garment

elastomere coated on the textile substrate.

- Electrodes for ECG

Dry electrodes are implemented on the inner surface of the garment consisting of a conductive silicone rubber printed on the textile substrate (Fig. 3). Conductivity is obtained by silver particles. The electrodes are placed left and right of the breast and belly.

- Moisture sensors

The conductivity of the textile is measured in order to determine the moisture of the garment as a measure for the sweating of the infant. Two pairs of flexible electrodes comparable to the ECG-electrodes measure the moisture-dependent resistance of the textile fibers on the back side of the vest.

- Temperature sensors

Temperature is measured by the change in resistance of two commercially available miniature NTC-thermistors that are integrated into the ribbon cable. They are positioned in the back and in the left armpit of the vest.

